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Dynamic Network Approach to Adversarial Modeling

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Real World Problem

Isolation Strategy Backlash State Change

- Jemaah Islamiyah - Philippines
- 30 June 2004 Arrests
  - Arnold Jabagat, alias Mike Kamansa (team leader)
  - Ahmad Ento, alias Carlos
  - Anwar Adam, alias Tuwa
  - Mama Tangkalasay, alias Sol
- Major bomb plot foiled

– *"What is the impact on the performance of the JI network?"*

- Regions that are progressive
  - Less tied to a single religion
  - More proactive on human rights
  - More proactive on women's rights
  - Higher standards of living/education
  - Less antagonistic to U.S. interests
- Major election coming up

What are the main lines of disagreement?

Who should take power to encourage progressiveness?

Who can be influenced to shape the outcome of the election?

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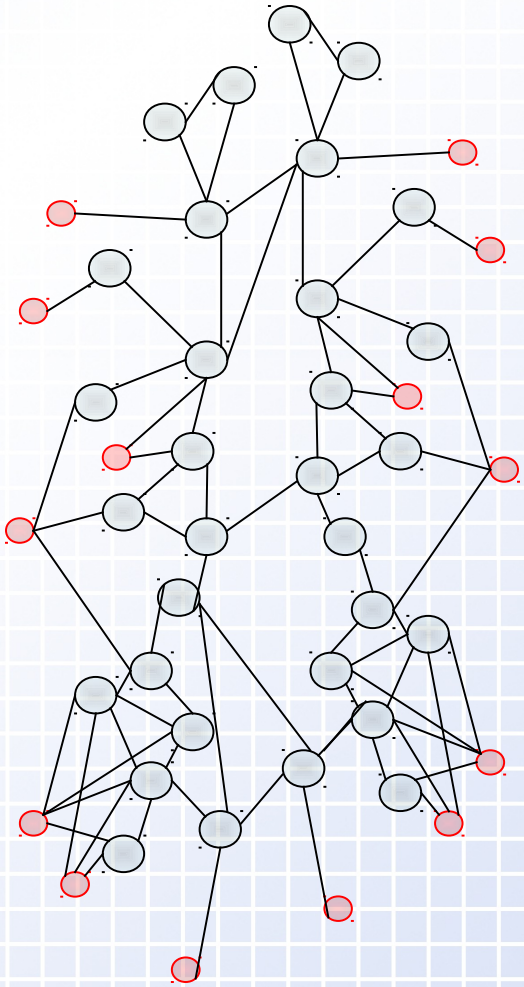
Analyst Questions

- Who to target (vulnerabilities)
  - What groups or individuals stand out
- How to influence
  - Are there important connections
- What is the “health” of the organization
- Where might there be missing data
- How different are two groups – or two sources – or the same group at two different times
- What will be the immediate or near term impact of a course of action
- Are there individuals whose network position puts them at risk



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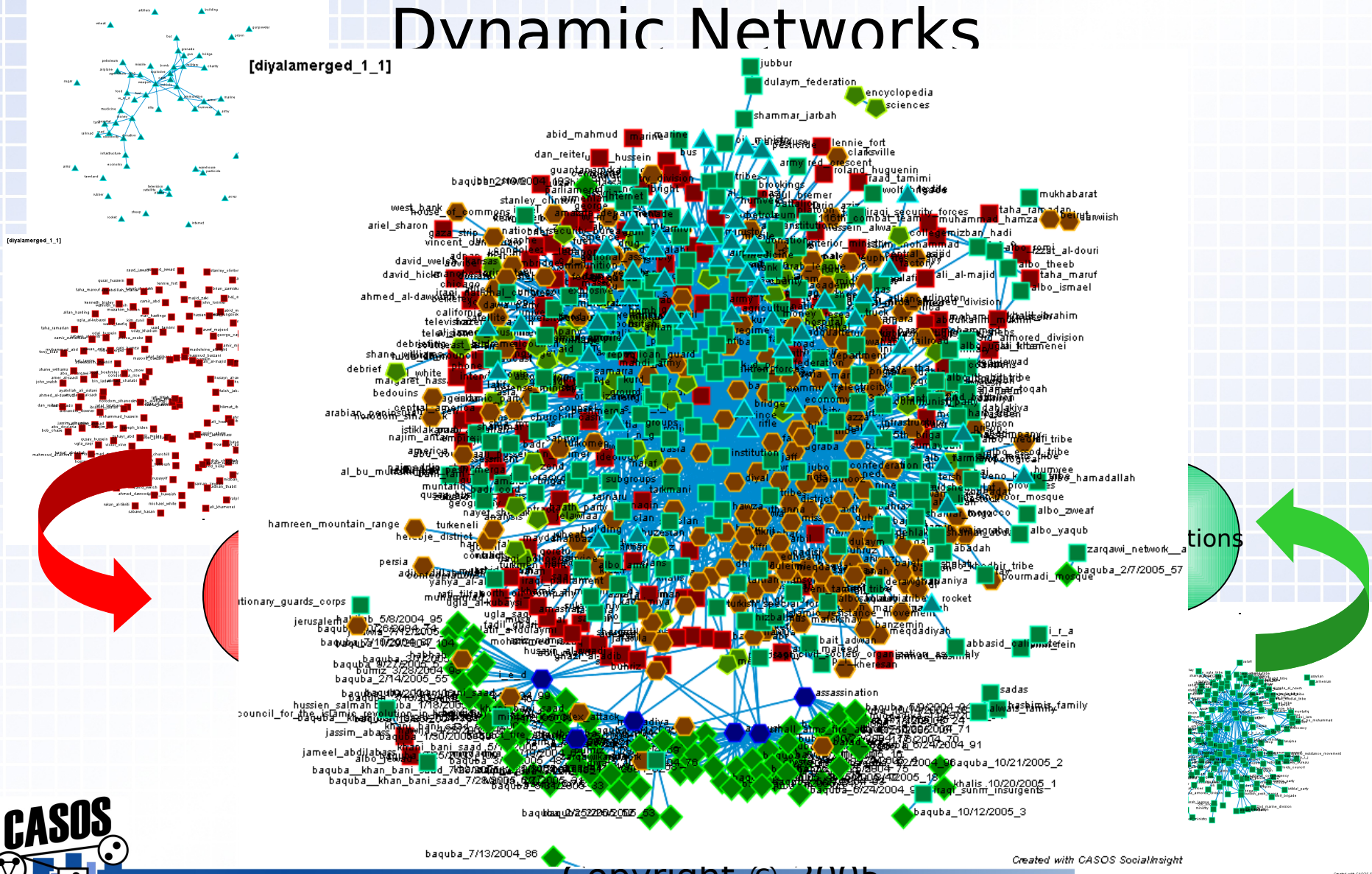
Dynamic Network Analysis: Interacting Dynamic Networks



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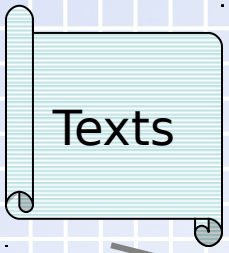
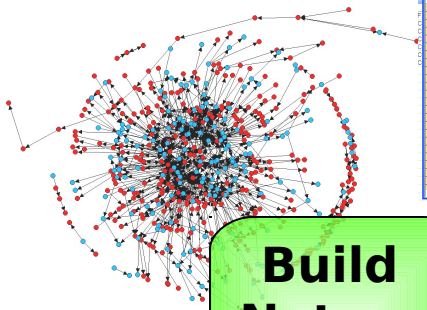
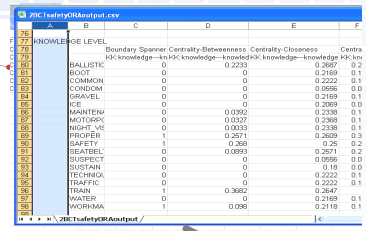
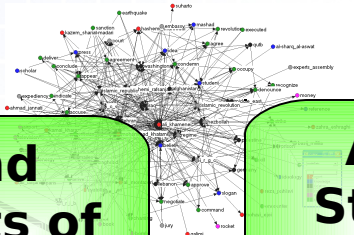
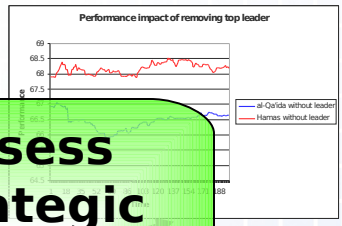










Build Network

Find Points of Influence

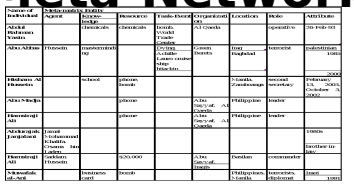
Assess Strategic Interventions

AutoMap
Automated extraction of network from texts
Visualizer

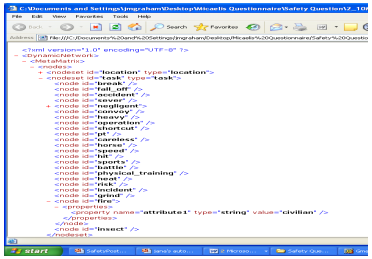
ORA
Statistical analysis of dynamic networks
Visualizer

DyNet
Simulation of dynamic networks
Visualizer

Meta-Network



DyNetML



Unified Database(s)

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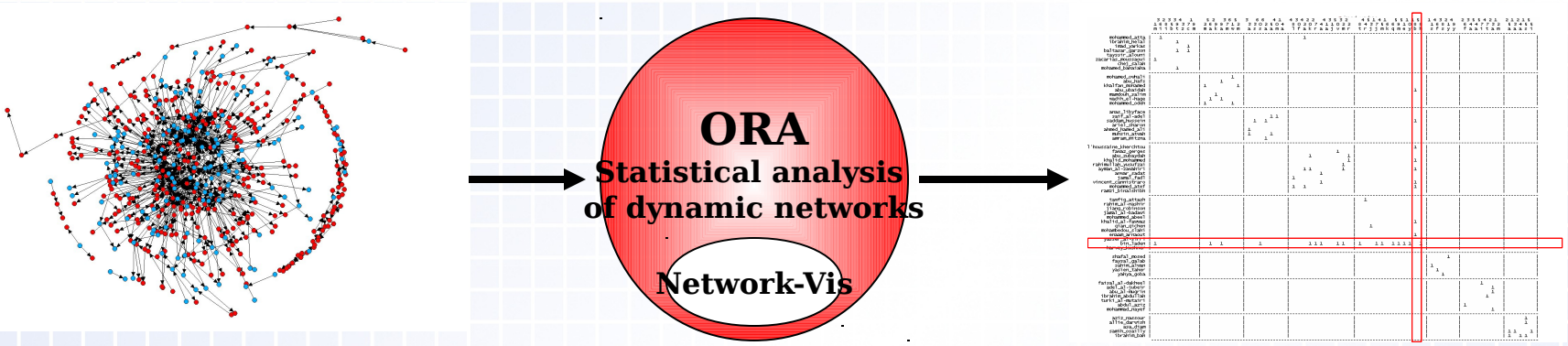
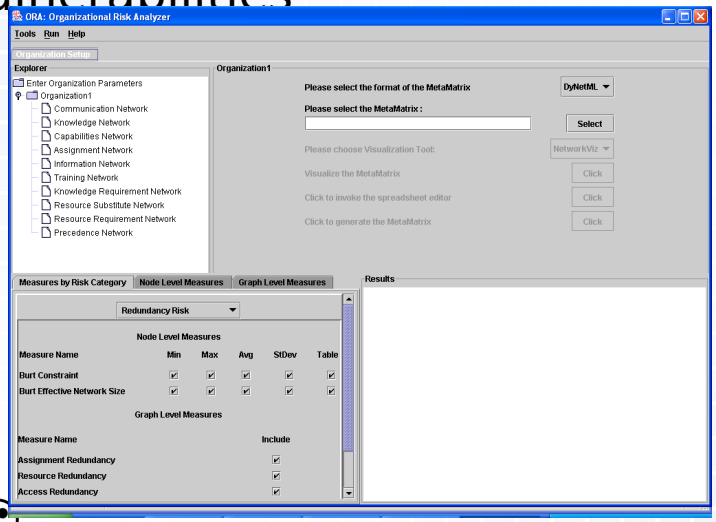
ORA: From networks to patterns



ORA: a DNA statistical analysis tool for locating patterns and identifying vulnerabilities



- Intelligence Report
- Management Report
- Immediate Impact Report
- Sub-Group Report
- Context Report
- Risk Report
- Ego “Sphere of Influence” Report

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Who to target (vulnerabilities)

- Centralities
  - Communication
    - Degree – most connected
    - Betweenness – most paths
- Exclusivities
  - Expertise
    - Knowledge – special expertise
    - Task – special experience
- Demands/Loads
  - Roles
    - Cognitive demand – emergent leader
    - Workload

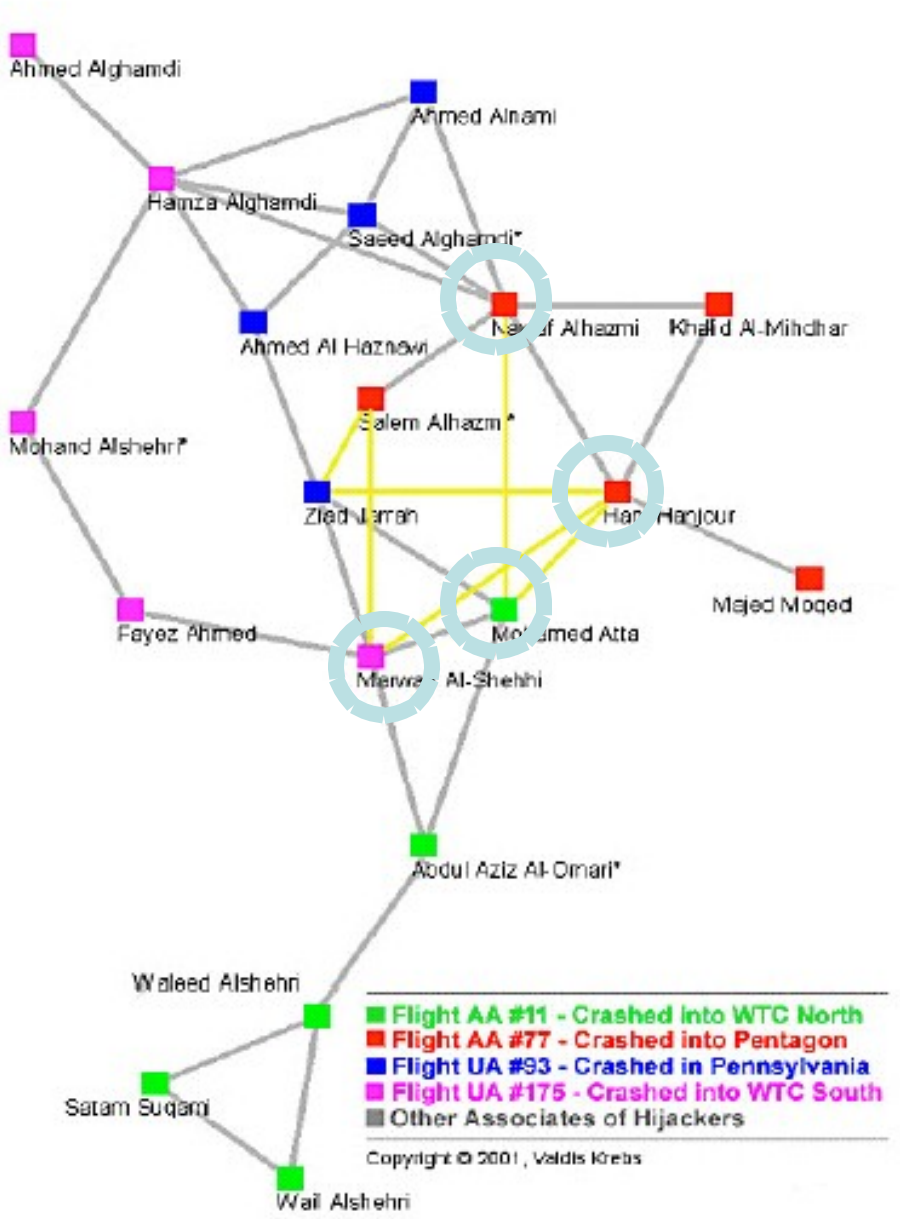

Figure 3 Trusted Prior Contacts + Meeting Ties [shortcuts]

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ORA Demonstration

al Qaeda 2000 - ORA Intel Report

	ORA Measure			
Rank	**Emergent Leader *(Cognitive Demand)***	**In the know *(Degree Centrality)***	**Influence *(Centrality-Betweenness)***	**Clique Leader *(Centrality-Eigenvector)***
1	**Zawahiri**	**Baasyir**	**bin_Laden**	**Baasyir**
2	**Baasyir**	**bin_Laden**	**Rafiki**	**Hambali**
3	**Azahari**	**Zawahiri**	**Fizazi**	**Mukhlas**
4	**Qatada**	**Hambali**	**Tabarak**	**Jabir**
5	**Mukhlas**	**Mukhlas**	**Benyaich2**	**Zulkarnaen**

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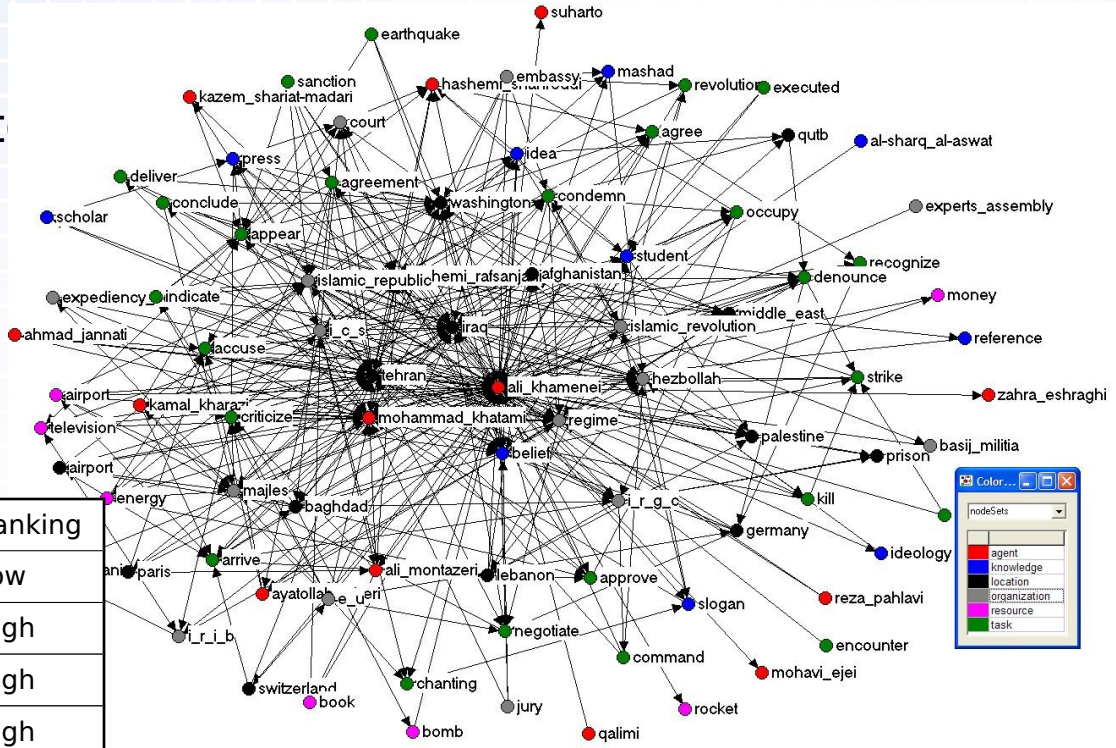
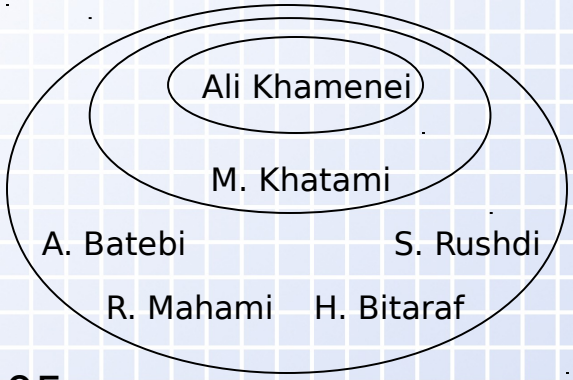
How to Influence

- For the target
  - Who are they connected t
  - What groups are they in
  - What do they know
  - What resources do they control
  - What activities are they involved in



Attribute	Score	Ranking
Interacts with	1	Low
Knowledge areas	10	High
Resource areas	7	High
Organizations associated with	17	High
Density of ego net	.097	High
Task exclusivity	.0226	High
Resource exclusivity	.010	High
Knowledge exclusivity	.0254	High
Degree Centrality	.017	Norm
Betweenness	.0024	High
Cognitive Demand	.033	High
Eigenvector Centrality	.001	Low



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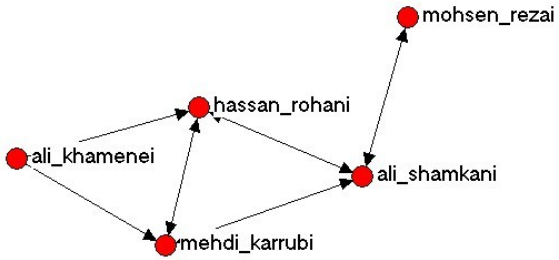
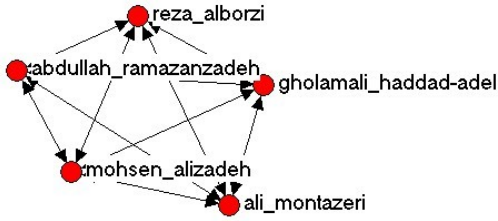
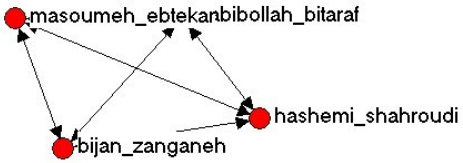
Estimating possible data errors

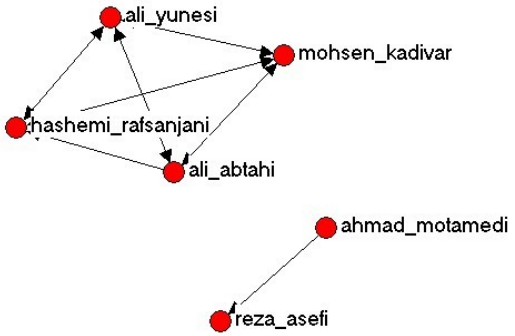
Who should be interacting?

- ***Homophily***
- ***Expertise***
- ***Tasking***









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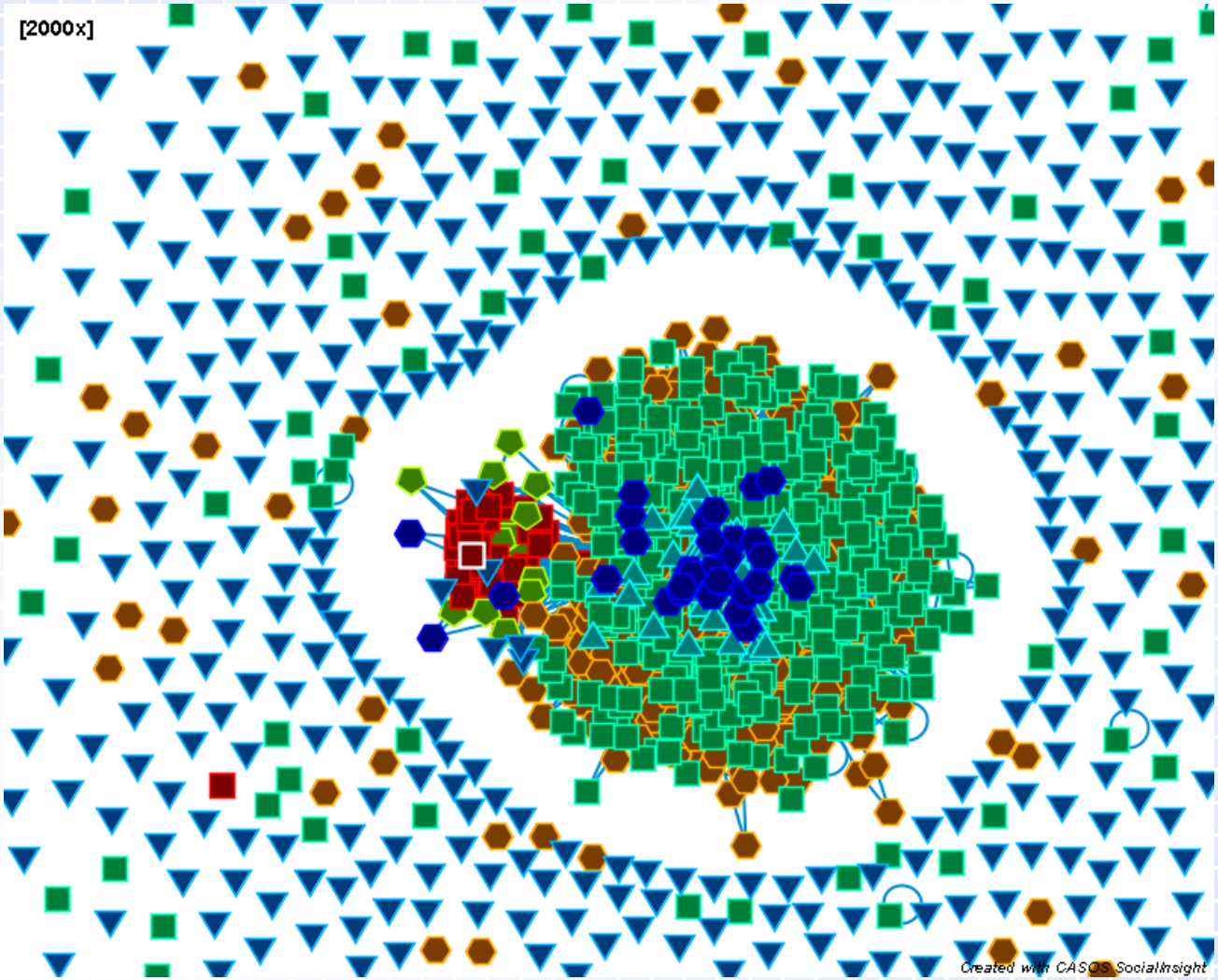
ORA Demonstration
al Qaeda 2000 - Output



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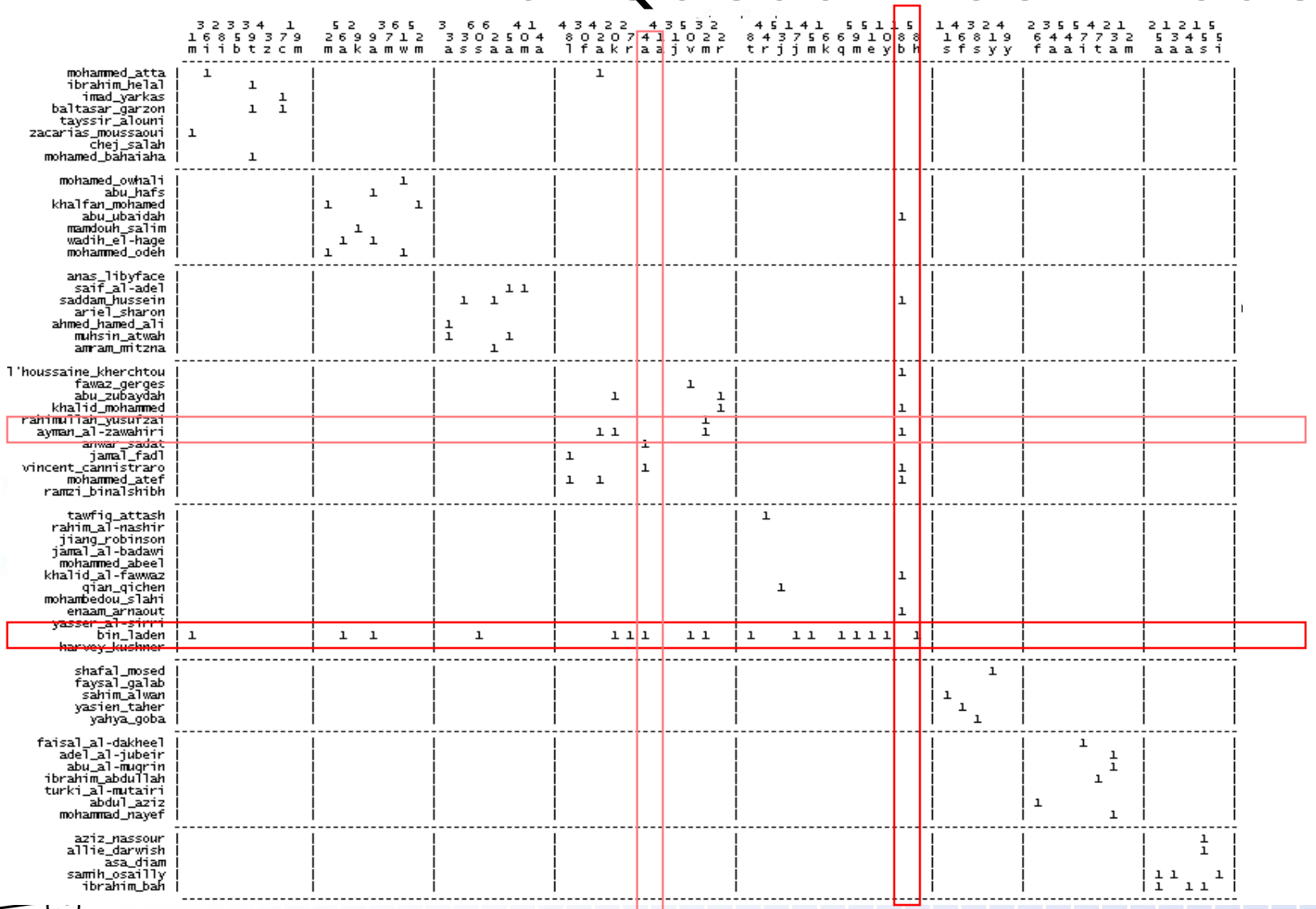
al Qaeda Block Model



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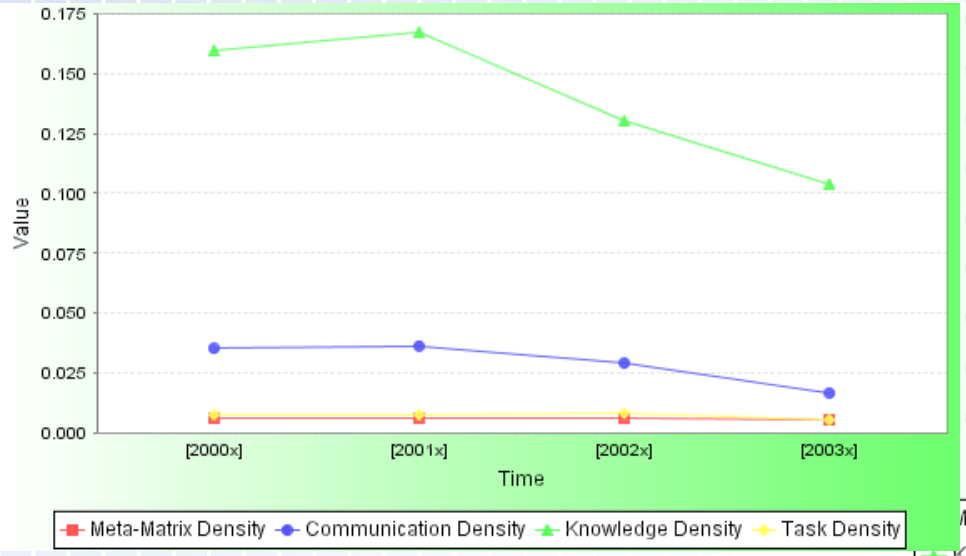
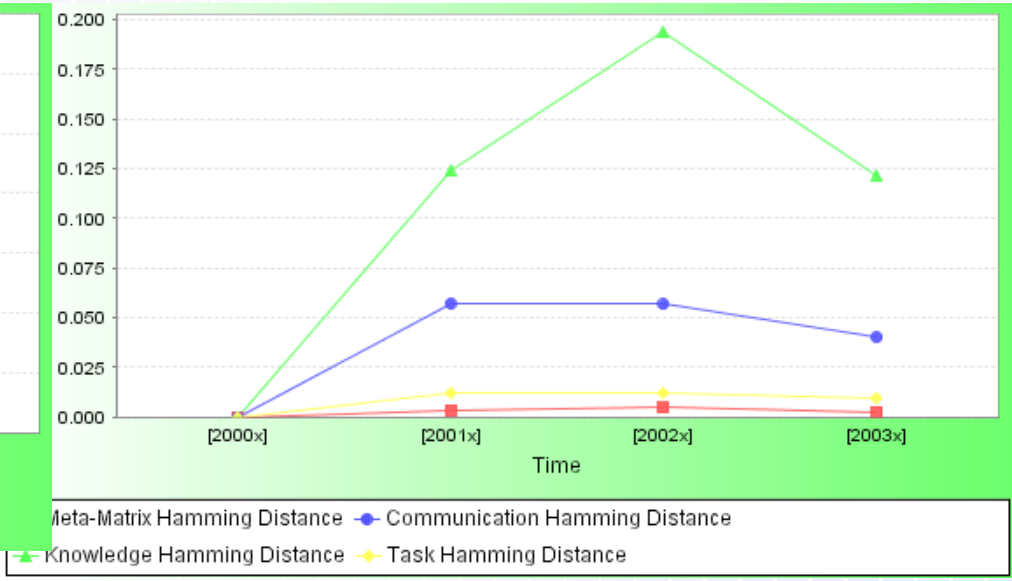
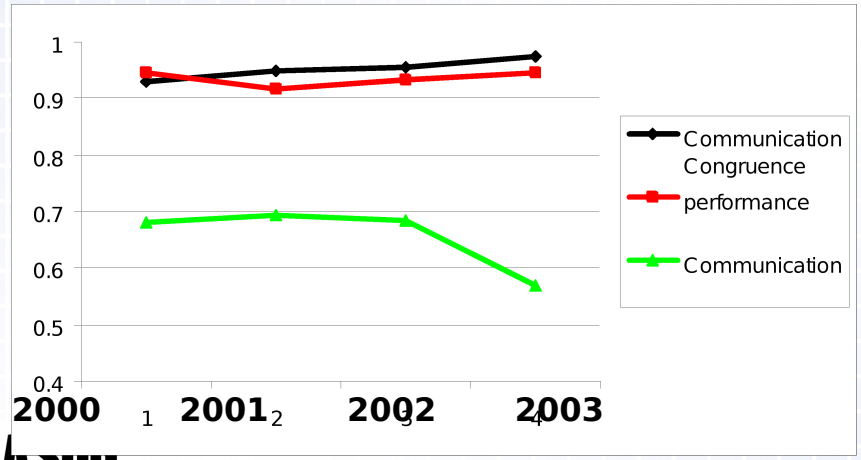
Change 2000-2003







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Overall Immediate Impact - Prediction

- *What if ? Remove top 5 emergent leaders*
- Change in performance
  - Anticipated drop – 4% percentage difference
- Change in information diffusion
  - Anticipated increase – 67% percentage difference
- New emergent leaders
  1. 0.0174 said_mortazavi
  2. 0.0137 kamal_kharazi
  3. 0.0127 reza_asefi
  4. 0.0120 morteza_sarmadi
  5. 0.0100 hashemi_shahroudi
- Value of “lowest” old emergent leader was .0246

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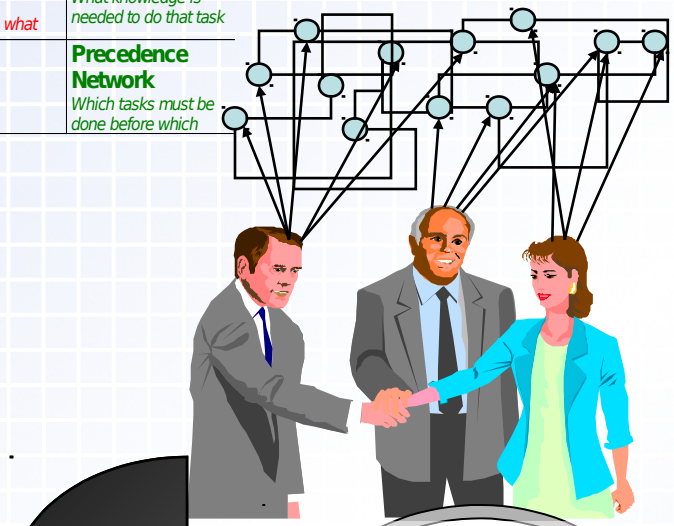
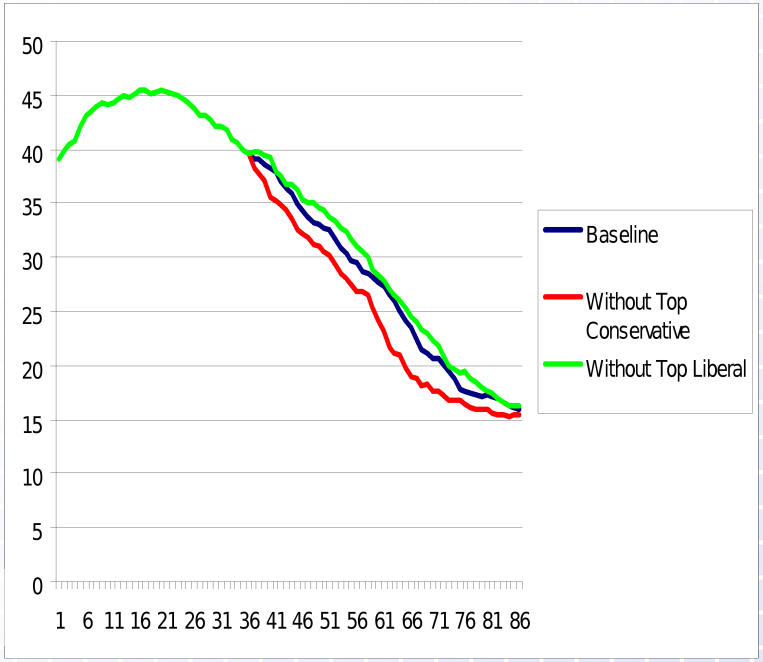
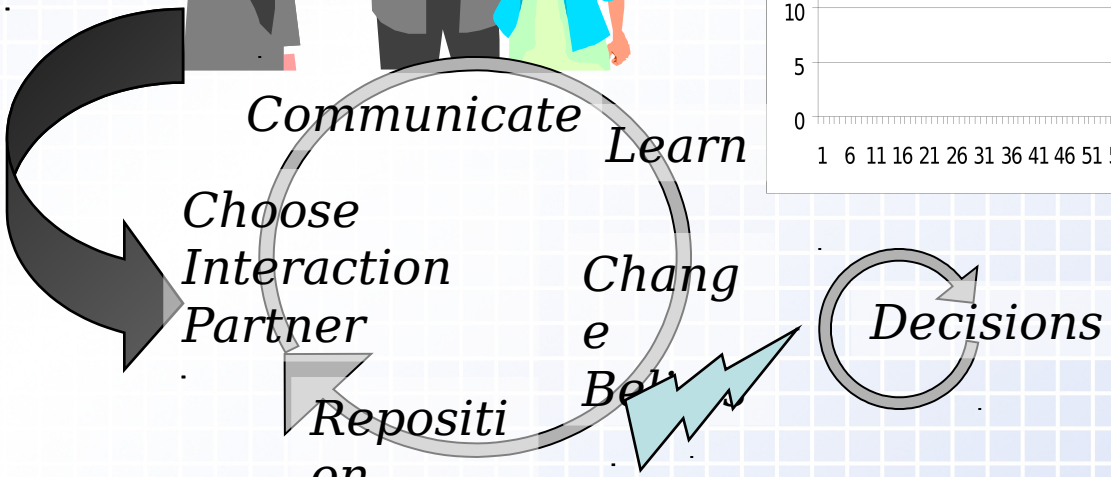
Change in Reformism – Near Term Prediction

	People	Knowledge	Tasks
People Relation	**Social Network** *Who knows who*	**Knowledge Network** *Who knows what*	**Assignment Network** *Who does what*
Knowledge Relation		**Information Network** *What informs what*	**Needs Network** *What knowledge is needed to do that task*
Tasks Relation			**Precedence Network** *Which tasks must be done before which*







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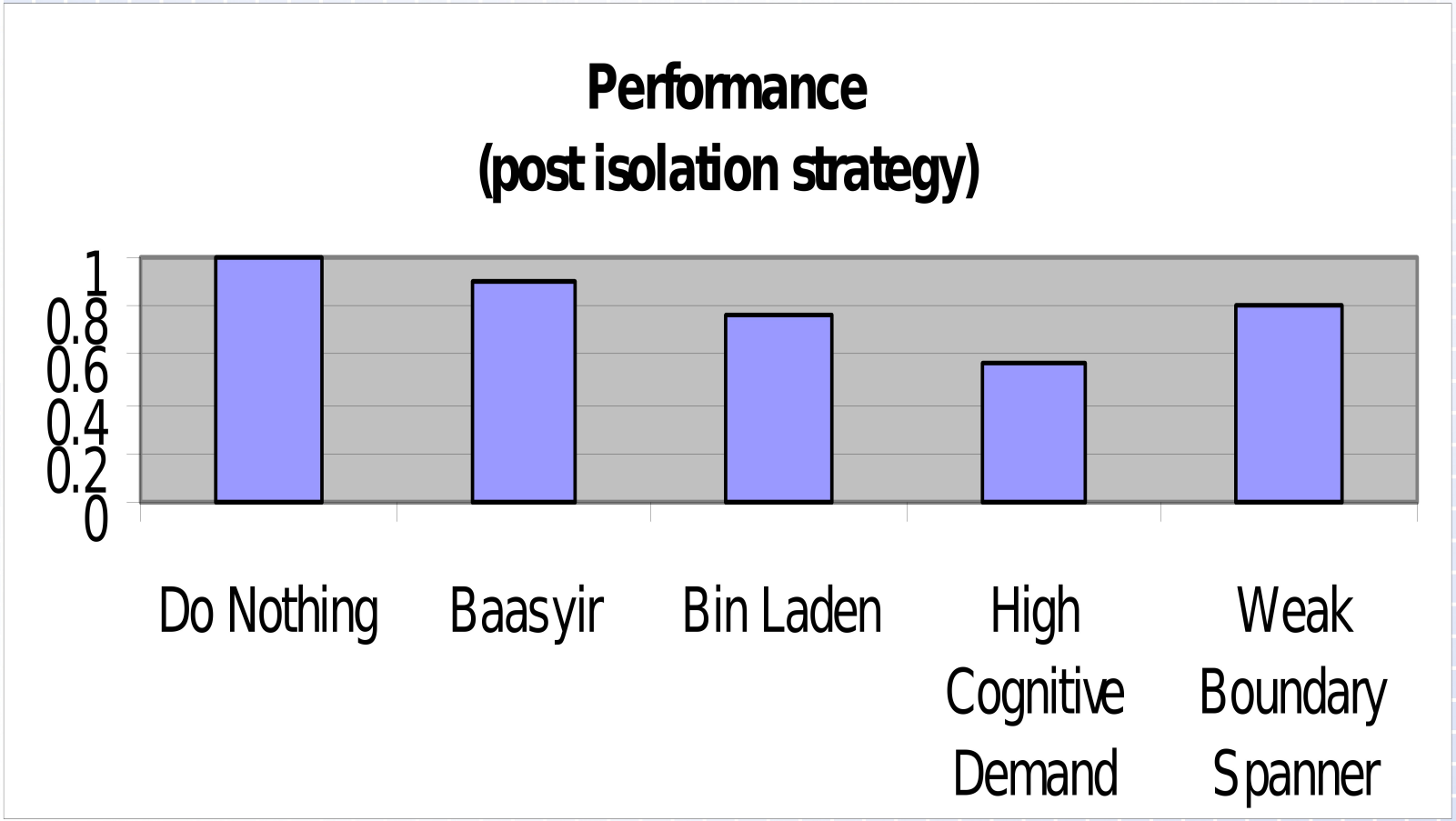
Near Term Impact - Prediction

Comparison of alternative courses of action



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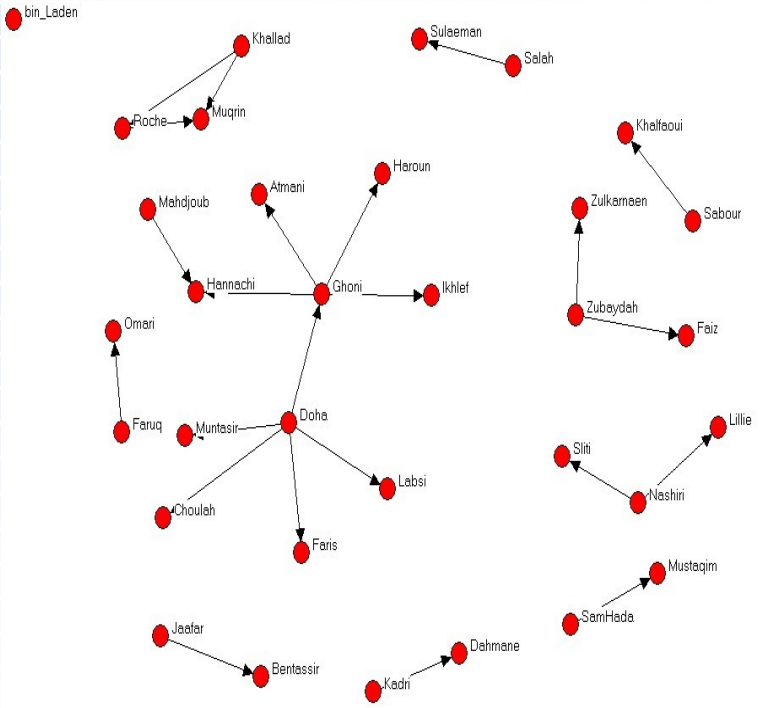
Change in Relations – Near Term - Prediction

Bin Laden Isolation→ New Network Relationships



New Relationships based on bin Laden Isolation			
From	**To**	**Value**	**NormValue**
Salah	**Sulaeman**	**0.07378**	**1**
Nashiri	**Sliti**	**0.016457**	**0.223052**
Ghoni	**Haroun**	**0.012465**	**0.168949**
Zubaydah	**Faiz**	**0.012083**	**0.163765**
Sabour	**Khalfaoui**	**0.011504**	**0.155918**
Ghoni	**Ikhlef**	**0.011457**	**0.155283**
Nashiri	**Lillie**	**0.01078**	**0.146111**
Ghoni	**Atmani**	**0.01067**	**0.144618**
Doha	**Ghoni**	**0.009806**	**0.132915**
Mahdjoub	**Hannachi**	**0.009584**	**0.129906**
Roche	**Muqrin**	**0.009504**	**0.128819**
Ghoni	**Hannachi**	**0.009374**	**0.12705**
Doha	**Faris**	**0.009175**	**0.124359**

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CASOS Tools

- ORA – statistical toolkit for meta-matrix, identifies vulnerabilities, key actors (including emergent leaders), and network characteristics of groups, teams, organizations, C2 – used with army battle labs, risk estimation NASA
- DyNetML – XML based interchange language for relational data
- AutoMap – Semi-automated text analysis
- Social Insight – network visualization

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Agent-based Modeling for Dynamic Networks -CASOS Complex Adaptive DNA Models

- Construct – MAS-DNA model for examining group change under diverse cultural, social and technological contexts
- NetWatch – impact of data integration, sharing and control on ability to detect evolving network
- BioWar – city scale multi-agent network model of response to weaponized biological and chemical attacks
- OrgAhead – multi-agent network model of evolving organizational forms
- DyNet – MAS-DNA model for examining change in networked systems under uncertainty
- MTE – MAS-DNA model for predicting action and response in urban and state level settings

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